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Claims

1. A device for determining a movement of an eye (1), which comprises an illumination unit (16, 29, 42, 48, 56), which generates optical radiation during operation and emits it as an illumination ray bundle (13, 13', 13") for illumination of at least one region on the cornea (7) of the eye (1),
a distance-determining unit (17), which senses, in a temporally resolved manner, the illumination ray bundle (13, 13', 13") returned by the cornea (7) as a detection ray bundle (14, 14', 14") and generates a distance signal using the received optical radiation of the detection ray bundle (14, 14', 14"), said signal corresponding to a distance of the cornea (7) from a reference plane (12, 12', 12"), which is defined relative to the distance-determining unit (17), and
an evaluating unit (11) which, using said distance signal, generates a position or movement signal corresponding to a position or movement of the eye (1).

2. The device as claimed in Claim 1 or 2, wherein the illumination unit (16, 29, 42, 48, 56) is provided such that a diameter of the illumination ray bundle (13, 13', 13") on the cornea (7) of the eye (1) arranged in front of the device is between 2 µm and 20 µm during operation.

3. The device as claimed in any one of the preceding Claims, wherein the distance-determining unit (17) comprises an interferometer portion (18) which, together with the cornea (7), forms an interferometer during operation.

4. The device as claimed in Claim 3, wherein the illumination unit (16) is provided to emit optical radiation having a predetermined temporal coherence length, the interferometer portion (18) comprises at least one beam splitter (21) arranged in the path of the illumination ray bundle (13, 13', 13") so as to form a reference ray bundle (22) from the optical radiation of the illumination unit (16), at least one optical functional element (21) for superimposing the detection ray bundle (14, 14', 14") onto the reference ray bundle (22), and a unit (25, 26) for

varying the optical path length of the reference ray bundle (22) between the beam splitter (21) and the optical functional element (21) or the optical path length of the path of the illumination ray bundle (13, 13', 13") after the beam splitter (21) and/or between the spot (15, 15', 15") illuminated by the illumination ray bundle (13, 13', 13") on the cornea (7) and the optical functional element (21), and the distance-determining unit (17) comprises a detection unit (19, 20), which suitably senses the intensity of the superimposed reference and detection ray bundles (22; 14) and transforms them into a distance signal.

5. The device as claimed in Claim 4, wherein the unit (25, 26) for varying the optical path length comprises a reflector (25) which is movable back and forth in a linear manner.

6. The device as claimed in Claim 4, wherein the unit for varying the optical path length comprises a reflector arrangement, which is rotatable or pivotable about an axis, said reflector arrangement comprising a plurality of reflecting portions each differently spaced apart from the axis.

7. The device as claimed in Claim 1 or 2, which comprises illumination optics (31, 58) for focusing the illumination ray bundle (13, 13', 13") for at least one wavelength in a predetermined range of possible positions of the cornea (7) and wherein the distance-determining unit (17) in a detection beam path comprises detection optics (31, 32; 31, 41; 31, 49; 49, 58), a small-aperture stop (33) arranged following said detection optics and located in a stop plane, and a detection unit (34, 35; 43, 45; 50, 51) arranged following said aperture stop (33) for detecting the optical radiation behind the small-aperture stop (33), wherein the stop plane is conjugated with an object plane (39) associated with the wavelength, said object plane being located in a range of possible positions of the cornea (7).

8. The device as claimed in Claim 7, wherein the position of the illumination and/or detection optics (31, 32; 31, 41; 31, 49; 49, 58) and/or of the aperture stop (33) and/or the focal length of the illumination and/or detection optics (31, 32; 31, 41; 31, 49; 49, 58) and/or the position of the illuminated spot can be changed by means of a drive (38).

9. The device as claimed in Claim 7, wherein optical radiation of different wavelengths can be emitted by the illumination unit (42, 48, 56), and ray bundle forming optics (53) of the illumination unit (48), the illumination optics and/or the detection optics are dispersive (31, 41; 49, 58).

10. The device as claimed in any one of Claims 7 to 9, wherein the illumination unit (42) is adapted for emitting optical radiation in at least two different spectral ranges.

11. The device as claimed in any one of Claims 7 to 9, wherein the illumination unit (48, 56) comprises a source of radiation (52) for emitting optical radiation in a predetermined spectral range.

12. The device as claimed in any one of Claims 7 to 11, wherein the detection unit (50, 51) is provided for spectrally and temporally resolved detection of the optical radiation behind the small-aperture stop (33).

13. The device as claimed in Claim 10, wherein the detection unit (43, 45) is adapted for detection of the optical radiation behind the small-aperture stop (33) in a manner timed with the change of the spectral ranges of the illumination ray bundles (13, 13', 13").

14. The device as claimed in any one of Claims 7 to 13, wherein the illumination optics (58) and the detection optics (58, 49) comprise a common objective (59).

15. The device as claimed in Claim 14, wherein the common objective (59) has a predetermined longitudinal chromatic aberration.

16. The device as claimed in any one of the preceding Claims, comprising at least one illumination unit (16, 29, 42, 48, 56), which emits two illumination ray bundles (13, 13', 13") and which illuminates two different areas on the cornea (7) of the eye (1), and comprising at least one distance-determining unit (17), which receives, in a temporally resolved manner, detection ray bundles (14, 14', 14") reflected by said two areas on the cornea (7) and generates distance signals corresponding to distances of the cornea (7) from two reference planes (12, 12', 12"), said reference planes (12, 12', 12") each being defined for one of the detection ray bundles (14, 14', 14") relative to the distance-determining unit (17) and the evaluating unit (11) evaluating the distance signals and generating position or movement signals which correspond to a position or movement of the eye (1) in two spatial directions.

17. The device as claimed in any one of Claims 1 to 15, comprising at least one illumination unit (16, 29, 42, 48, 56), which emits three illumination ray bundles (13, 13', 13"), which illuminate three different areas forming the corners of a triangle on the cornea (7) of the eye (1), and comprising at least one distance-determining unit (17), which receives, in a temporally resolved manner, detection ray bundles (14, 14', 14") reflected by said three areas on the cornea (7) and generates distance signals corresponding to distances of the cornea (7) from three reference planes (12, 12', 12"), said reference planes (12, 12', 12") each being defined for one of the detection ray bundles (14, 14', 14") relative to the distance-determining unit (17) and

the evaluating unit (11) evaluating the distance signals and generating position or movement signals which correspond to a position or movement of the eye (1) in three spatial directions.

18. A method of determining a movement of an eye (1), wherein optical radiation is radiated onto the cornea (7) of the eye (1) as an illumination ray bundle (13, 13', 13"), distance signals corresponding to the distance of the cornea (7) from a predetermined reference plane (12, 12', 12") are generated in a temporally resolved manner, using the optical radiation returned by the cornea (7) as detection ray bundles (14, 14', 14"), and position or movement signals corresponding to a position or movement of the eye (1) are generated from the distance signals.

19. The method as claimed in Claim 18, wherein the illumination ray bundle (13, 13', 13") has a diameter of between 2 µm and 20 µm at the cornea (7).

20. The method as claimed in Claim 18 or 19, wherein a reference ray bundle (22) is coupled out from the illumination ray bundle (13, 13', 13"), the detection ray bundle (14, 14', 14") is superimposed on the reference ray bundle (22) and the distance signal is generated by detection of interferences of the superimposed ray bundles.

21. The method as claimed in Claim 20, wherein the optical path length for the reference ray bundle (22) before superposition, the illumination ray bundle (13, 13', 13") after splitting off of the reference ray bundle and/or the detection ray bundle (14, 14', 14") before superposition are varied, the intensity of the superimposed reference and detection ray bundles (14, 14', 14") is detected in a temporally resolved manner, and a distance signal is generated on the basis of the detected intensity.

22. The method as claimed in Claim 21, wherein a reflector (25) is moved in order to vary the optical path length.

23. The method as claimed in Claim 22, wherein a plurality of reflecting surface portions are rotated about an axis in order to vary the optical path length, said surface portions having different radial spacings from the axis.

24. The method as claimed in Claim 18 or 19, wherein the illumination ray bundle (13, 13', 13") is focused for at least one wavelength into a predetermined range of possible positions of the cornea (7), the detection ray bundle (14, 14', 14") is focused, by means of detection optics (31, 32; 31, 41; 31, 49; 49, 58), into the region of a small-aperture stop (33) located in a stop plane, said stop plane being conjugated with an object plane (39) which is associated with the wavelength and which lies in a predetermined range of possible positions of the cornea (7), and

the distance signal is generated by detection of the optical radiation passing through the small-aperture stop.

25. The method as claimed in Claim 24, wherein the range of possible distances of the cornea (7) from the reference plane (12, 12', 12") is scanned by changing the distance between the object plane (39) and the small-aperture stop (33).

26. The method as claimed in Claim 24, wherein optical radiation of different wavelengths is used, and the illumination and/or detection ray bundle (14, 14', 14") is guided through at least one strongly dispersive optical functional element (41; 53; 59).

27. The method as claimed in Claim 24, wherein illumination ray bundles (13, 13', 13") with optical radiation in at least two different spectral ranges are alternately used in a predetermined time sequence.

28. The method as claimed in any one of Claims 24 to 27, wherein the illumination ray bundle (13, 13', 13") comprises optical radiation in a spectral range of 400 to 1700 nm.

29. The method as claimed in any one of Claims 26 to 28, wherein the intensity of the detection ray bundle (14, 14', 14") behind the small-aperture stop (33) is detected in a spectrally and temporally resolved manner.

30. The method as claimed in Claim 27, wherein the intensity of the detection ray bundle (14, 14', 14") behind the small-aperture stop (33) is detected in a manner timed with the change of the spectral ranges of the illumination ray bundles (13, 13', 13").

31. The method as claimed in any one of Claims 18 to 30, wherein the illumination ray bundle (13, 13', 13") is radiated onto an area of the cornea (7) at an angle of incidence of less than 10°, preferably less than 5°.

32. The method as claimed in any one of Claims 18 to 31, wherein at least two different areas on the cornea (7) are illuminated by at least two different illumination ray bundles (13, 13', 13"), distance signals relating to the distances of the cornea (7) from corresponding predetermined reference planes (12, 12', 12") are generated in a temporally resolved manner, using the optical radiation respectively returned by the cornea (7) as detection ray bundles (14, 14', 14"), and position or movement signals relating to a position or movement of the eye (1) in at least two spatial directions are generated on the basis of said distance signals.

33. The method as claimed in any one of Claims 18 to 31, wherein at least three different areas on the cornea (7) forming corners of a triangle are illuminated by at least three different illumination ray bundles (13, 13', 13"), distance signals relating to the distances of the cornea (7) from corresponding, predetermined reference planes (12, 12', 12") are generated in a temporally resolved manner, using the optical radiation respectively returned by the cornea (7) as detection ray bundles (14, 14', 14"), and position or movement signals relating to a position or movement of the eye (1) in at least three spatial directions are generated on the basis of said distance signals.

34. The method as claimed in Claim 1, wherein illumination and detection radiation is guided over the eye synchronously with a therapeutic beam.